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Memoirs of the Department of Agriculture in India

No. 1. A Contribution towards a Monograph of the Indian Coniopterygidæ (Neuroptera)

BY

C. L. WITHYCOMBE, Ph.D., M.Sc., D.I.C.

No. 2. Papers on Indian Tabanidæ

VIII. The Bionomics and Life-histories of some of the common Tabanidæ of Pusa

AND

No. 3. Some observations on the Life-history and Habits of Phycus brunneus, Wied. (Family Therevidæ)

BY

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AGRICULTURAL RESEARCH INSTITUTE, PUSA

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A CONTRIBUTION TOWARDS A MONOGRAPH OF THE INDIAN CONIOPTERYGIDÆ (NEUROPTERA).

BY

C. L. WITHYCOMBE, PH.D., M.SC., D.I.C.

(Received for publication on 27th January 1925.)

MR. T. BAINBRIGGE FLETCHER has been so kind as to forward to me for determination the whole of the material of Indian Coniopterygidæ contained in the Collection of the Agricultural Research Institute, Pusa. This collection I had long hoped to see, as the Indian Coniopterygidæ have received very scant attention from entomologists. Only one species has been described from the entire mainland of India, and one from Ceylon. Hagen[1] described *Coniopteryx cerata* from Ceylon in 1858. Lefroy[2] in 1909 mentioned Coniopterygids as having been taken at Surat and Simla, but no description was given. Banks[3] in 1913 described the first Coniopterygid from India proper, under the name of *Malacomyza terminalis*, the specimens having been taken by Mr. Bainbrigge Fletcher at Belgaum, Bombay Province, in 1910. Thus, as compared with our knowledge of Coniopterygidæ from other parts of the world, that of Indian Coniopterygidæ was extremely limited.

In the present paper eleven species are described as new. A new genus is proposed for *M. terminalis*, Bks. These are all from material in the Pusa Collection. A note upon the male and cocoon of *Coniopteryx cerata*, Hag., has been added, and the male genitalia of this species are figured for the first time.

Of the Pusa material there remain two specimens of a very small *Coniopteryx*, which, owing to their bad condition, I do not wish to describe. They bear the following labels :—

1. Shevaroys—Yercaud. 23 April—4 May. 13, 4,500 feet, Fletcher Coll.
2. On mushroom, Pusa, Bihar, Umrao Bahadur, 10. I. 16. C. S. 106.

The Coniopterygidæ are small Neuropterous insects with a somewhat reduced system of wing venation. The body is covered to a greater or less extent with a white waxy powder which is secreted by hypodermal glandular areas on the body

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[1] Hagen, 1858. *Coniopteryx cerata* sp. n. *Verh. zool.-bot. Ges. Wien*, VIII, p. 484.
[2] Lefroy, 1909. *Indian Insect Life*. Calcutta. 786 pp., p. 156.
[3] Banks, 1913. *Malacomyza terminalis*, n. sp. *Trans. Amer. Ent. Soc.*, XXXIX, p. 220.

and is rubbed over the body and wings by the insect shortly after emergence. In this respect, therefore, Coniopterygidæ resemble the Aleurodidæ, and they are frequently mistaken for the latter. The following are the main points of difference :—

Aleurodidæ.	*Coniopterygidæ.*
Antennæ small, 7-jointed as a rule. Mouthparts prolonged into a sucking rostrum or beak. Tarsus 2-jointed. Wing venation very simple. In the living insect the wings are held rather flattened and outspread when at rest.	Antennæ longer, more than 15-jointed. Typical biting mouthparts. Tarsus 5-jointed. Wing venation simple, but more complex than that of Aleurodids. In the living insect the wings are held more steeply roofed over the body.

The classification of the Coniopterygidæ is based on wing venation. Characters so derived are usually reliable for generic determination and often for specific, but in certain species the position of cross-veins is exceedingly variable.

The system of venational terminology here adopted is that of Comstock and Needham. Comstock[1] gives a figure of the venation of *Semidalis* which serves well to indicate the nature of the various veins. It should, however, be pointed out that the apparent cross-vein from Sc to R_1 and the terminal portion of R_1 are to be regarded as Sc_2. This has been shewn in *Conwentzia*[2] and I have since been able to confirm it for *Semidalis*.

The number of antennal joints often serves as a good specific character. It is generally variable within limits. Greatest range of variation is seen in those species of which the antennal joints number thirty or more.

The tarsal ratio of the hind legs has been used by Enderlein and is valuable in some species, but it is unfortunately not so constant and reliable as one would wish.

The male genitalia appear to afford the most invariable characters of all and wherever possible it is advisable to have males for comparison in making determinations. For the proper examination of the genitalia it is necessary to make balsam preparations subsequent to treatment with caustic potash. The male genitalia of Coniopteryginæ are built upon much the same plan throughout, with a pair of penis sclerites, to the internal extremities of which are attached muscles in such a way that the sclerites can be everted and their external hooks used in grasping. Often there is a central intromittent organ. In the Aleuropteryginæ, on the other hand, judging by the two males examined, the tendency seems to be to the reduction of penis sclerites as grasping hooks and to the greater development of a central chitinous cylinder which may possibly be used as an intromittent organ. It is withdrawn well within the body at rest and can probably be everted considerably (Figs. 6 and 7).

Biology. Coniopterygidæ seem to occur principally on trees or shrubs and are not found as a rule on low vegetation. They prey upon small Rhynchota and Mites. The adults also feed on honeydew, etc.

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[1] Comstock, 1918. The Wings of Insects. New York. p. 212.
[2] Withycombe, 1922. The Wing Venation of the Coniopterygidæ. *Entomol.*, LV, pp. 224—225.

Eggs (Fig. 1) are white to orange in colour. They are usually laid singly at the edges of leaves and are oval, often somewhat flattened, and pointed at the micropylar pole. The chorion is sculptured with a honeycomb-like pattern.

The larva (Fig. 2) is shortly spindle- or top-shaped, covered only with fine hairs. The head is small, rounded and inconspicuous, with eyes consisting of groups of five simple elements. Antennae are two-jointed, the basal joint being short and the distal portion elongate and plumose with fine hairs. The mouthparts are in the form of a cone covered above by the labrum, but in *Aleuropteryx*[1] the sucking spears are rather elongate and they are only covered basally by the labrum. Labial palpi are more or less club-shaped and are three-jointed.

The thorax and abdomen merge into one another, tapering at the extremity of the latter. Legs are well developed for walking, but the tarsus is composed of only one segment. There are two tarsal claws.

The larva feeds voraciously on Mites, such as red spider, and small Rhynchota. Towards the end of active life it spins a flat circular cocoon, of silk which is secreted by the modified Malpighian tubes, using the anal extremity as a spinneret. This cocoon is generally spun upon the bark of the tree or on the flat underside of a leaf. It is often of double structure, there being an outer and an inner envelope. In *Coniopteryx cerata*, Hag., from Ceylon, the cocoon is drawn into radial ridges dorsally.

The pupa has all the appendages fairly free and would be termed a *pupa libera*, but it does not move until just before emergence. Then it cuts a semi-circular slit in both envelopes of the cocoon with its pupal mandibles and may walk completely out of the cocoon or the adult may emerge from the pupal skin while still projecting slightly from the cocoon. The wings are extended and dried, and the waxy powder secreted from the body glands is rubbed over them by the hind legs. Other particulars as to the biology of Coniopterygidæ have already been given.[2]

Economic Importance. The Coniopterygidæ are to be considered as entirely beneficial to the agriculturalist since both as larvae and as imagines they are predaceous upon Rhynchota, Mites, etc., and they are often very abundant locally. Unfortunately, they are rather liable to be confused with Aleurodidæ: the principal distinguishing characters have already been indicated. The importance of the Coniopterygidæ from an economic standpoint and their possible utilisation has been more fully discussed elsewhere.[3]

Collecting and Mounting. Coniopterygidæ may be collected by beating trees and shrubs and by other ordinary methods. The imagines do not fly much and are feeble on the wing. Apparently the males alone are attracted to light. Larvae

[1] Löw, 1885. Beitrag zur Kenntniss der Coniopterygiden. S.-B. *Akad. Wiss. Wien, math.-nat.* Cl., XCI, Abt. I, pp. 73—88.

[2] Withycombe, 1922. Notes on the Biology of Some British Neuroptera. *Trans. Ent. Soc., London*, pp. 501—594.

[3] Withycombe, 1924. Note on the Economic Value of the Neuroptera, with special reference to the Coniopterygidæ. *Ann. App. Biol.* XI, No. 1, pp. 112—125.

occur upon trees and shrubs but are difficult to detect. They are not easy to rear in captivity, but if captured when full fed they will spin up, pupate and emerge without difficulty. Cocoons may be found upon the bark of trees and the undersides of leaves. Imagines can easily be bred from these. Being extremely fragile, captured Coniopterygids are best brought home alive or in spirit. If killed in the field they are very liable to damage unless carefully packed.

The white waxy powder covering these insects has been mentioned by Enderlein as being of some value in systematic work, but this value is quite insignificant and for specific determination it is better to rely on structural characters. The writer prefers to bring specimens home alive in small boxes and, after noting superficial characters, colour, etc., to preserve in 70 per cent. alcohol; or small tubes ($\frac{1}{8} \times 1$ inch) have been used to isolate specimens after killing in the field. Coniopterygidæ are difficult to pin, on account of their small size, and often a dry specimen cannot be determined. It is therefore necessary to make microscopic preparations, as from such alone can one observe many structural characters.

Enderlein[1] recommends mounting one pair of wings dry and the other pair in balsam. The body of the insect is then treated with cold caustic potash solution over a period may be of some days. I find that prolonged maceration in cold potash softens the chitin to a much greater extent than does boiling in an even stronger solution for a few minutes, and the disadvantage of such softening is manifested when transferring to balsam; the legs and antennae are not sufficiently rigid to resist external pressure when the clearing medium diffuses out of the insect and into the balsam, thus resulting in the collapse and shrinkage of these appendages. This very annoying occurrence is frequent and the only remedy is to take the specimen back again into alcohol and then much more gradually into balsam.

Personally I find the following routine best. The specimen is mounted on one slide in parts under two No. 1 circular coverslips of 1 cm. diameter. A pair of wings may be mounted dry under a third coverslip, but this is not really necessary if any striking peculiarities of the wax powder have first been noted. The powder cannot be used for specific determination. I usually mount both pairs of wings under one coverslip as follows. Place the specimen in absolute alcohol or in n-propyl alcohol and with a pair of needle-pointed forceps remove the wings of one side. Place a very small drop of camsal balsam (Gilson's formula) on a microscope glass slip to the left of the centre and in this drop of balsam place and arrange the wings. Now remove and arrange the wings of the other side in opposition to the first pair. It will be found that the camsal balsam dries fairly quickly and thus fixes the wings in position. Should the balsam set too quickly, add a fraction of a drop of n-propyl alcohol if it is required to reset the wings. This will soften the balsam and the wings can then be rearranged. Put aside the slide to set completely and to dry under a bell glass free from dust.

[1] Enderlein, 1906. Monographie der Coniopterygiden. *Zool. Jahrb.*, XXIII, Abt. f. Syst., pp. 173—242.

Now transfer the body to 10 per cent. potassium hydroxide in water and boil for two or three minutes until cleared. I use a short test tube $\frac{5}{8} \times 3$ inches, over the mouth of which is fastened a piece of fine gauze to prevent loss of the specimen by spurting of the potash. Spurting can be avoided if heating is conducted carefully and if a fresh quantity of solution is used each time, but it is advisable to take precautions against mishaps. When the specimen is cleared it is transferred to glacial acetic acid and is then brought to the boil to drive off any bubbles of carbon dioxide which may form, due to the presence of some potassium carbonate in the potassium hydroxide. (Personally I use a small silica crucible, with an inverted watchglass as cover, for this heating. The acetic acid condenses and drops back into the vessel from the centre of the watch-glass. Heating can be done rapidly without fear of cracking the vessel. A silica vessel cannot, of course, be used for boiling potash). After cooling, the cleared specimen is transferred from acetic acid, which dehydrates, to n-propyl alcohol or finally to amyl alcohol. I much prefer the latter as a final bath, even though preceded by propyl or other alcohol. Amyl alcohol is not very hygroscopic, and can therefore be used with advantage in the rainy season; also its density more nearly approaches that of the camsal balsam, and it does not diffuse out of the specimen too rapidly, so that shrinkage is hardly likely to occur on transference to balsam. After allowing to remain in amyl alcohol for about ten minutes, the specimen may be transferred to a drop of camsal balsam placed on the slide,—this time to the right of the centre. Here the specimen is arranged and the balsam again allowed to set, under a bell jar. Before the balsam sets, the maxillae and labium are removed, if required. This can easily be done with a finely sharpened needle under a Greenough binocular microscope. Push the needle into the mouth of the insect between the mandibles, press downward on to the slide and draw out the labium and maxillae together. The mouthparts sometimes afford good characters.

When the balsam has set completely, *i.e.*, after twenty-four hours or so, a fresh drop of balsam is added and a coverslip is lowered on to each drop. The slide is again put aside to set for a day or two.

By this method well spread preparations can be obtained which are easy of determination and which lend themselves to camera lucida drawing.

I now use camsal balsam, Gilson's formula in n-propyl alcohol, entirely for Coniopterygidæ. Its low refractive index, 1·478, is valuable as it increases the visibility of unstained chitinous structures. The medium is not easily affected by a damp climate. It sets rapidly; an advantage in fixing specimens to the slide. When set hard it can be dissolved if necessary in any serially lower alcohol than n-propyl.

Key to Genera of Indian Coniopterygidæ.

A. Media of forewings with two prominent bristles near the middle. Media in hindwings running for more than half its length closely applied to or fused with the fore cubitus, Cu_1. Galea of maxilla 3-jointed. Abdominal ventral sacs present.

Sub. Fam. **Aleuropteryginæ.** (Figs. 3—7 and 17, 18).

B. Lower arm R_{4+5} of radial sector in forewings attached to media in such a way as to give it the appearance of being a branch of media. Media in fore and hindwings forked. Wings of fairly normal shape and not strikingly fringed.

—— *Niphadicera*, gen. nov. (Figs. 3—6 and 17).

BB. Fork of radial sector normal. Media in both fore and hindwings simple and not forked. Wings narrow, curved and sub-acute, fringed with long hairs.

—— *Coniocompsa*, End. (Figs. 7 and 18).

AA. Media in forewings without two more conspicuous bristles. Media in hindwings not closely applied to forecubitus Cu_1. Galea of maxilla composed of a single segment. No abdominal ventral sacs.

Sub. Fam. **Coniopteryginae.** (Figs. 19-28).

B. Hindwings reduced in size.

Conwentzia, End. (Fig. 19).

BB. Wings sub-equal, *i.e.*, hindwings normal.

C. Radial sector unbranched in both fore and hindwings.

Nimboa, Nav. (Figs. 20 and 21).

CC. Radial sector forked in fore and hindwings.

D. Media in hindwings simple and not forked.

Coniopteryx, Curt.* (Figs. 22—25).

DD. Media in hindwings forked.

Semidalis, End. (Figs. 26—28).

NIPHADICERA, gen. nov.

Genotype *Malacomyza terminalis*, Banks, ♂.

(Figs. 3-6 and 17.)

An examination of a male " cotype " (strictly paratype) of Banks' species shows that *Malacomyza terminalis*, Bks., belongs to the sub-family Aleuropteryginæ and not to the Coniopteryginæ, for the following reasons.

The galea of the maxilla is three-jointed (Fig. 4). There are four pairs of abdominal ventral sacs (Fig. 6). The male genitalia are of typical form (Fig. 6). The media in the hindwings fuses with the fore-cubitus for about half its length (Fig. 17).

The new genus *Niphadicera* may be distinguished by the curious basal joints of the antennae in the male, which are similar to those of *Niphas*, End. (Fig. 3) ;

* In using the name *Coniopteryx*, Curtis, I have followed Enderlein.[1] Banks,[2] on the other hand, with good reason, prefers the name *Malacomyza* Wesmael. The difficulty has arisen through a mistake of Curtis. This last author[3] has given a poor and hardly adequate description of his genus *Coniopteryx*, but he has added a good and unmistakeable figure of another genus (*Semidalis* End.). One has to decide whether to accept the good figure or the poor description as that of *Coniopteryx* Curtis. Personally, since authors cannot be held responsible for artists' vagaries, I prefer to follow the bad description, and therefore I have used Enderlein's name *Semidalis* for the genus figured by Curtis, while retaining the name *Coniopteryx* for the genus described.

[1] Enderbin, 1906. Monographie der Coniopterygiden. *Zool. Jaharb.*, XXIII, Abt. f. Syst., pp. 173-242.

[2] Banks, 1907. A Revision of the Nearctic Coniopterygidæ. *Proc. Ent. Soc. Washington*, VIII, pp. 77—86.

[3] Curtis, 1834. British Entomology, XI, p. 528.

by the cross vein Rs to M being placed near origin of Rs and striking M more basad than origin of Rs; by the cross vein M to Cu_1 being placed before level of origin of Rs (Fig. 17); by the complete fusion of M and Cu_1 for some distance in the hindwing; and by several minor characters, described below, taken as a whole.

There are four pairs of abdominal ventral sacs as in Coniocompsini. The wing venation appears to be intermediate between Aleuropterygini and Coniocompsini. The male antennal character may possibly be present in other Aleuropteryginæ, but in *Aleuropteryx* it is the second joint of the antenna of the male which is modified.

It is unfortunate that Banks has selected a female as holotype of his species, but he briefly refers to what he considers to be the corresponding male. While there is probably no doubt as to the correct assignation of this male to Banks' species *terminalis* yet in view of the possibility I consider it advisable to give below a description of the male "cotype" upon which my genus *Niphadicera* is based. Banks' own description of his species is appended. From this latter I am inclined to differ slightly on the matter of wing venation.

Description of male "cotype" of *M. terminalis*, Banks, (det. N. Banks) genotype of *Niphadicera*, gen. nov.

Testaceous, covered with white powder.

Head brownish (Fig. 3). Eyes dark brown. Antennae 18-jointed. The basal, first six joints are pale. The seventh joint is darkened and the next ten joints are brownish-black. The last joint is of pale colour. The basal joint of each antenna is much enlarged and elongated. It is hollowed dorsally and in this hollow area are pits bearing each a short hair. The latero-dorsal portions of the frons grow out as curved, horn-like projections (Fig. 3) and on the antero-ventral concave faces of these are situate some closely placed pits larger than those of the antennae and devoid of hairs. Each pit is surrounded by a ring of minute projecting dots and outside this ring is a distinct margin. This pit-area of the frontal cornua is clearly a grasping surface.

Maxillae (Fig. 4) having lacinia with some stiff curved bristles internally at apex, galea three-jointed, palpus five-jointed, the first four joints being dark brown and the terminal joint paler. Labial palpi (Fig. 5) wholly pale in colour.

Remainder of body and legs testaceous. Genitalia very peculiar (Fig. 6) and wholly retractile, with a central eversible portion which is almost completely tubular and which bears distally some sensory hairs. Hind tarsal ratio of legs 8 : 2 : $1\frac{1}{2}$: $1\frac{1}{2}$: 3.

Wings pale, with a very slight brownish tinge (Fig. 17). Venation pale. Margins of wings minutely ciliated, the cilia being longest in the anal angle of hindwings.

In the forewings the origin of Rs from R is indistinct and an indistinct cross-vein unites Rs, near its origin, with M. Rs is apparently unbranched, but actually the origin of R_{4+5} appears as a very faint cross-vein. The terminal portion of R_{4+5} appears to belong to M. Cross-veins Sc to R_1 (=Sc_2) and R_1 to Rs are very pale and hardly visible. They are placed almost opposite each other. On the basal half of M are placed two prominent bristles, as is common in Aleuropteryginae. Cu_1 and Cu_2 run near together basally.

In the hindwings cross-veins Sc to R_1(=Sc_2) and R_1 to Rs are placed apart. Rs arises very near base of wing and forks only near apex of wing. M is fused with Cu_1 for much of the basal part of its length. Origin of M_{1+2} hardly visible. Cu_2 and anal veins weak.

Length of body	2·2 mm.
Length of anterior wing	2·3 mm.
Length of posterior wing	2 mm.

Habitat. Bombay Prov., Belgaum; 2,500 feet; 12 Aug. 1910, T. B. F. In Coll. Pusa Research Institute.

Banks'[1] description of *Malacomyza terminalis*, Bks., is as follows :—

> " Densely clothed with white powder, cilia white. Antennae white on basal seven joints, beyond deep black; palpi black on base, white on last joint; body brownish, with white powder. Forewings with cross-vein just before fork of the median vein; radial sector geniculate at base; in hindwings but one fork. In the male the antennae are thick, the basal joint enlarged at tip, and seen from the side with concave upper edge; on the head of male is a swollen cap or top piece; in the female the head is normal, and the basal joint of the antennae long, but not enlarged at tip; legs with fusiform tibiae.
>
> Expanse 4 mm.
>
> Type.—♀. From Belgaum, Bombay Province, India, 12th August, 2,500 feet. "

In this description I would point out that of the forewing Banks says " with cross-vein just before fork of the median vein ", but his figure shows the cross-vein to be placed distally to the fork of M. One of the characteristics of my genus *Niphadicera* is that the cross-vein Rs to M is situated well basad and not near fork of media. Again, Banks says " in the hindwings but one fork ". This also I would query. I consider these to be errors such as are inevitable from the examination of dry material alone. I define the genus *Niphadicera* from the male " cotype " of *terminalis*, Banks (teste Banks) examined by me. It must be left to future workers, having access to the holotype, to decide whether the type of *terminalis*, Bks., is correctly placed in this genus.

[1] Banks, 1913. *Malacomyza terminalis*, n. sp. *Trans. Amer. Ent. Soc.*, XXXIX, p. 220.

The structure of the male antennae in *Niphadicera* is clearly useful for grasping, by opposition of the basal antennal joints to the concave pit-area on the lateral frontal projections of the head. Probably the pairing is similar to that which I have described in *Parasemidalis*[1] where the male grasps the female from below. Probably the male *Niphadicera* grasps the hind coxae or femora of the female with his antennae. (This method of pairing is certainly peculiar, if it occurs, and it is comparable with that of some Entomostraca.)

Coniocompsa indica, sp. n.

(Figs. 7 and 18.)

Pale brown; wings mottled with darker. Hindwings conspicuously fringed White powdery covering of insect not very dense. (This probably varies.)

Head rounded, fuscous in colour. Eyes blackish. Antennae short, dark brown, 21-jointed. Each joint, except first two and last, is shorter than broad. Palpi pale brown, maxillary palpi about twice the length of labial. Lacinia of maxilla with seven, strong, tooth-like setae.

Thorax fuscous, with diffuse brown spots on shoulders of meso and metathorax. Abdomen pale, with only three pairs of ventral sacs. Genitalia as figured (Fig. 7) with a pair of forcipiform gonopophyses.

Legs dusky. Hind tarsal ratio in preparation apparently 13 : 3 : $1\frac{1}{2}$: 2 : 4.

Wings (Fig. 18) of shape and venation typical for *Coniocompsa*.[2] The forewing membrane is largely hyaline, but shows small, pale brown blotches mainly towards the apex and along the inner margin. The two large median bristles are borne on dark brown prominences of the vein. Hindwings hyaline, with the apex slightly tinged fuscous. The inner margins of both pairs of wings are fringed with long hairs, especially the hindwings.

Length of body	2 mm.
Length of anterior wing	2·1 mm.
Length of posterior wing	1·85 mm.

Habitat. Pusa, Bihar, 4-i-16, C. S. Misra.

Holotype ♂ in British Museum (Natural History).

This species differs from both the previously described species of *Coniocompsa*, *C. vesiculigera*, End., and *C. japonica*, End., principally in the greater number of antennal joints and in the slight amount of brown pigmentation of the wings.

Paratype. Damaged (? sex). This agrees with holotype in all essentials.

Pusa, Bihar, 3-iii-15, T. Bainbrigge Fletcher.

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[1] Withycombe, 1922. Notes on the Biology of Some British Neuroptera. *Trans. Ent. Soc. London*, pp. 501—594.

[2] Enderlein, 1906. Monographie der Coniopterygiden. *Zool. Jahrb.*, XXIII, Abt. f. Syst., pp. 173—242.

Conwentzia inverta, sp. n.

(Figs. 8 and 19.)

Testaceous, covered with white powder.

Head and palpi pale brown, antennae darker. Eyes black. The antennae have the two basal joints paler, beyond which the joints are dark brown in colour. Number of antennal joints thirty-three. Palpi lighter in colour than antennae.

Thorax, legs and abdomen pale brown ; genitalia (Fig. 8) slightly darker. Hind tarsi appear to be only four-jointed although the other tarsi are as usual five-jointed. (This appearance is probably due to a faulty preparation, as the chitin shows some signs of collapse and the last joints are likely to be telescoped into one another.) The ratio of the joints visible is 9 : $2\frac{1}{2}$: 2 : $3\frac{1}{2}$, representing the proportionate lengths of tarsal joints Nos. 1, 2, 3, and 5.

Forewings much larger than hindwings (Fig. 19). Veins fuscous, membrane tinged with fuscous. Towards the inner margin of wings this pigmentation fades and at the margin even the veins are invisible. In forewings Sc_2 crosses to R_1 before the point where cross-vein R_1 to Rs strikes R_1. This is a most unusual feature in Coniopterygidae although it is also found so in *Coniocompsa*. Cross-vein R_2 to Rs strikes the latter at its fork point. In the neighbourhood of this cross-vein the wing membrane is most darkly pigmented with brown, but the greater part of the cross-vein is indicated by a colourless streak. Owing to the lack of pigment cross-vein Cu_2 to 1st A is barely visible. It is, however, placed more proximally than cross-vein Cu_1 to Cu_2.

Hindwings reduced. Sc does not appear confluent with R_1. Rs is simple and unbranched. There is a cross-vein from Rs to M, although not very distinct.

Length of body	1·6 mm.
Length of anterior wing	2·5 mm.
Length of posterior wing	1 mm.

Habitat. On Cane, Pusa, India, 23-xi-14, C. S. Misra.

Holotype ♂ in British Museum (Natural History).

Nimboa basipunctata, sp. n.

(Figs. 9 and 20.)

Testaceous. Entire insect covered with white powder and showing darker blackish spots.

Head rounded, pale, with eyes blackish. Antennae pale, 26-jointed, the basal joint largest, second joint smaller, and rest almost equal. Palpi slightly darker in colour than antennae.

Remainder of body testaceous, but thoracic sclerites and genitalia of a darker brown. Male genitalia as figured (Fig. 9).

Legs pale brownish ; fore tibiae very hirsute apically and internally, fore femora do not show a very strongly developed row of setae. Hind tarsal ratio 10 : $2\frac{1}{2}$: $1\frac{1}{2}$: $1\frac{1}{2}$: 3.

Wing venation pale. Marginal hairs on wings minute. In the forewings (Fig. 20) the distal portion of Rs bends anteriorly towards R_1. Rs is unbranched. The faintly indicated cross-vein from Sc to R_1 (really Sc_2 [1]) is in a line with the cross-vein R_1 to Rs. Cross-vein from M to Cu_1 leaves the former well before its fork point. At the margin of wing, at the extremities of Rs, M_1+2, M_3+4, Cu_1 and Cu_2, are small, dark brownish pigment spots in the membrane. Another pigment spot occurs at the fork point of M, and a seventh spot basally on Cu_2. Cross-veins are also pigmented.

Hindwings wholly pale, testaceous. Sc_2 is not opposite cross-vein from R_1 to Rs but is placed slightly more distally. Rs is unbranched. Cu_2 and anal vein very weak. Three cross-veins in a curved line connect Cu_1, Cu_2 and A to margin basally.

Length of body	2 mm.
Length of anterior wings	2·3 mm.
Length of posterior wings	1·9 mm.

Habitat. Pusa, Bihar, 4-iv-08, C. S. Misra.

Holotype ♂ in British Museum (Natural History).

This species differs from *Nimboa guttulata*, Navas, in the disposition of Sc_2, in the anterior curving of the apex of Rs, and also in the presence of a basal pigment spot upon Cu_2.

Paratypes. (1) ♀. This female is similar to the male except for the absence of genital armature, also the antennae are 24-jointed, and in the wings Sc_2 leaves Sc slightly before cross-vein from R_1 to Rs.

Length of body	2 mm.
Length of anterior wings	2·2 mm.
Length of posterior wings	1·8 mm.

Habitat. Pusa, Bihar, ix-08, C. S. Misra, F. 49.

(2) sex ? A damaged specimen.

Pusa, Bihar, 4-iv-08, C. S. Misra.

Nimboa immaculata, sp. n.

(Fig. 21.)

Testaceous. Whole insect covered with usual white waxy powder. Immaculate.

Head rounded, pale brown. Eyes black. Eleven joints only of right antennae present, these being fuscous ; rest of antennae missing. Palpi fuscous.

[1] Withycombe, 1922. The Wing Venation of the Coniopterygidæ. *Entomol.*, LV, pp. 224—225.

Thorax and abdomen yellowish-brown, the thorax being darker.

Legs pale brown. Hind tarsal ratio 11 : 3 : $1\frac{1}{2}$: 1 : 3.

Wings with venation wholly pale in colour (Fig. 21). In the forewings the passage of Sc_2 is very indistinct. Cross-vein from R_1 to Rs is oblique and it may be that this apparent cross-vein is really R_{2+3} which has bent anteriorly and fused with R_1. This would account for Rs appearing unbranched. Apparent Rs does not fork but distally it bends anteriorly. Cross-vein from Rs to M_{1+2} leaves Rs at about its middle. Cross-vein from M to Cu_1 leaves stem of M.

In the hindwings passage of Sc_2 is distinct and slightly further out than cross-vein R_1 to Rs. The latter is again oblique, as in forewings.

Length of body	2 mm.
Length of anterior wings	2·3 mm.
Length of posterior wings	1·9 mm.

Habitat. Hoshiarpur, Punjab; on *Lantana* flowers, 21-xi-18, A. G. R.

Holotype ♀ in British Museum (Natural History).

Goniopteryx exigua, sp. n.

(Figs. 10 and 22.)

Pale brown. Head, appendages, and genitalia darker. White powder covering whole insect.

Head rounded, somewhat compressed dorso-ventrally. Eyes blackish. Antannae fuscous, 25-jointed. Joints mainly sub-spherical except first two joints which are more elongate. Terminal joint sub-conical. Palpi slightly paler than antennae.

Thorax and legs testaceous, with four darker spots latero-dorsally on thorax. Hind tarsal ratio 9 : 2 : $1\frac{1}{2}$: $1\frac{1}{2}$: $2\frac{1}{2}$.

Abdomen yellowish-brown. Male genitalia dark-brown, and as figured (Fig. 10).

Wings (Fig. 22) slightly tinged brownish, venation pale brown. In forewings Sc_2 and cross-vein R_1 to R_{2+3} are almost opposite each other. In hindwings these two veins are in a straight line, *i.e.*, opposite. There appears to be no cross-vein from Rs to M in hindwings.

Length of body	1·8 mm.
Length of anterior wing	1·75 mm.
Length of posterior wing	1·4 mm.

Habitat. Abbottabad, June 1916, Fletcher coll.

Holotype ♂ in British Museum (Natural History).

Paratype ♀. Similar to male holotype, but pigmentation more blackish and intense.

Head light fuscous. Antennae 23-jointed, dark fucsous. Palpi paler.

Abdomen with chitin unpigmented except at apex where paraprocts alone are dark fuscous. These are small and rounded.

Wings with membrane tinged fuscous. Sc_2 and cross-vein R_1 to R_{2+3} almost opposite in all four wings.

Habitat. On *Bael* leaves, Pusa, 23-xi-1914, Ram Saran.

Coniopteryx ambigua, sp. n.

(Fig. 23.)

Pale brown; antennae dark brown; a brown spot on each shoulder; wing membrane smoky. Entirely covered with white waxy powder.

Head pale, with eyes blackish. Antennae dark fuscous, 24-jointed, the two basal joints swollen and the terminal joint somewhat pyriform. Palpi dark fuscous, terminal joint of each pair hatchet-shaped.

Thorax fuscous, as also legs. A darker brown spot on each shoulder of mesothorax, less distinct on metathorax. Hind tarsal ratio 8 : 2 : 1 : $1\frac{1}{2}$: 2.

Wing membrane somewhat smoky, veins mostly well-marked and fuscous. In forewings (Fig. 23) passage of Sc_2 and cross-vein from R_1 to R_{2+3} almost opposite each other. These two veins are indistinct. R_{2+3} bends somewhat anteriorly towards Sc_2 at its distal extremity.

In hindwings (Fig. 23) Sc_2 and cross-vein from R_1 to R_{2+3} are again almost opposite each other. Cross-vein from Rs to M absent, although there is some indication of this cross-vein in the right wing only. (In one paratype there is a cross-vein from R_{3+4} to M in the right hindwing.) Marginal setae are small in both pairs of wings, but they are more distinct in hindwings and especially along the inner margin of hindwings.

Length of body	1·6 mm.
Length of anterior wings	1·8 mm.
Length of posterior wings	1·5 mm.

Habitat. Kateri Road, Nilgiris, 23-viii-22, P. V. Isaac.

Holotype ♀ in British Museum (Natural History).

Paratypes. (1) ♀. Antennae 24-jointed. Hind tarsal ratio 9 : $1\frac{1}{2}$: 1 : $1\frac{1}{2}$: 2. Cross-vein R_{3+4} to M present in right hindwing only.

Habitat. 2,300 feet. Dehra Dun, on *Lantana* flowers, 27-xi-18, A. G. R.

(2) ♀. Antennae 24-jointed. No cross-vein from Rs to M in either hindwing.

Habitat. Khasis; 5,000 feet. Shillong. October 1916, Fletcher coll.

Coniopteryx obtusa, sp. n.

(Figs. 11 and 24.)

General colour dark fuscous, but the covering of white powder gives a greyish hue.

Head fuscous, with eyes black. Palpi fuscous. Antennae missing.

Thorax dark fuscous, as also legs. Femur of foreleg with a row of six strong setae basad and a few others, smaller and less strong, more distally. Hind tarsal ratio 14 : 5 : 3 : $1\frac{1}{2}$: 4.

Abdomen greyish. Genitalia dark fuscous and of characteristic form (Fig. 11). The two paraprocts (?) are pointed and lie dorsally.

Wings (Fig. 24) with a fuscous tinge, much rounded apically. Sc_2 further out on wing than cross vein R_1 to R_{2+3} in all wings. No cross vein from Rs to M apparent in hindwings. Marginal setae of wings inconspicuous.

Length of body	1·5 mm.
Length of anterior wing	2 mm.
Length of posterior wing	1·7 mm.

Habitat. Pusa, Bihar, 4-iv-08, C. S. Misra.

Holotype ♂ in British Museum (Natural History).

Coniopteryx pusana, sp. n.

(Figs. 12 and 25.)

Pale brown, with head and its appendages, thorax, legs and genitalia darker. Body and wings covered with white waxy powder.

Head rounded, eyes blackish. Antennae long (almost as long as hindwing) dark brown, 32-jointed. (The right antenna is 30-jointed, but is abnormally formed.) Palpi, with terminal joint especially, dark brown. Maxillary palpi with terminal joint elongate and flattened, somewhat trowel-like, about four times the length of penultimate joint. Labial palpi with last joint broad and more or less hatchet-shaped.

Thorax with legs fuscous. Hind tarsal ratio 10 : $2\frac{1}{2}$: $1\frac{1}{2}$: $1\frac{1}{2}$: 2.

Genitalia as figured (Fig. 12) in colour dark brown.

Wing membrane smoky, veins fuscous (Fig. 25). In forewing Sc_2 leaves Sc a little further out on wing than cross-vein R_1 to R_{2+3}. Hindwings rather narrow. Sc_2 leaves Sc well before apex of wing. Cross-vein R_1 to R_{2+3} slightly basad to passage of Sc_2 from Sc to R_1. No cross-vein from Rs to M.

Length of body	2 mm.
Length of forewing	2·2 mm.
Length of hindwing	1·8 mm.

Habitat. On sugar cane, Pusa, 2-ii-21, S. C. Sarkar.

Holotype ♂ in British Museum (Natural History).

Paratypes. There are nine paratypes, three ♂♂ and six ♀♀. Venationally these are all similar, except for very slight differences. Thus in forewings "cross-vein" Sc_2 and R_1 to R_{2+3} may come almost opposite each other. The number of antennal joints in the males varies from thirty-one to thirty-three and in the

females from twenty-nine to thirty-one. In all specimens the cross-vein M to Cu[1] is absent in the hindwings. The shape of the hindwing is quite characteristic.

(1) ♂ Antennae 31-jointed. Wings typical. On sugar cane, Pusa, 1-ii-1921, S. C. Sarkar.
(2) ♂ Antennae 33-jointed. Wings typical. On sugarcane, Pusa, 2-ii-1921, S. C. Sarkar.
(3) ♂ Antennae 33-jointed. Wings typical. On sugarcane, Pusa, 3-ii-1921, S. C. Sarkar.
(4) ♂ Antennae 31-jointed. Wings typical. On sugarcane, Pusa, 3-ii-1921, S. C. Sarkar.
(5) ♂ Antennae 30-jointed. Wings typical. On sugarcane, Pusa, 1-ii-1921, S. C. Sarkar.
(6) ♂ Antennae 31-jointed. Wings typical. On sugarcane, Pusa, 2-ii-1921, S. C. Sarkar.
(7) ♂ Antennae 30-jointed. Wings typical. On sugarcane, Pusa, 2-iii-1921, S. C. Sarkar.
(8) ♂ Antennae 30-jointed. Wings, one pair, typical, others missing. Pusa Bihar, 4-iv-08, C. S. Misra.
(9) ♂ Antennae 30-jointed. Wings typical. Pusa, Bihar, 17-i-13. C. S. Misra.

Coniopteryx cerata, Hagen.

(Fig. 13.)

Hagen[1] described this species from Ceylon in 1858, his original description being as follows :—

" Fusca, albo-pruinosa ; antennis corporis longitudine, articulis duobus basalibus crassis, longis, cylindricis, ceteris moniliformibus : alis aequalibus, sectore primo simplici, secundo bifurcato ; pedibus pallidis.

Long. c. alis 3 mill. ; Exp. alar. 5 mill."

This description is too general to fix the identity of Hagen's species, in the present, more advanced state of our knowledge, but Enderlein[2] has given an amplified redescription of a female which he considers to be conspecific with Hagen's. Enderlein gives the following description :—

" Hell braun. Beine sehr blass, Kopf und Antennen dunkel braun. Hinterleib weisslich. Spitze bräunlich. Antennen 26 gliedrig, kräftig und von etwa halber Vorderflügellänge ; trotzdem das vorliegende Exemplar ein ♀ ist, sind die 5 ersten Geisselglieder sehr kurz, teilweise viel kürzer als dick, und tragen ausserdem an der Innenseite einige ähnliche Schüppchen, wie sie bei den ♂♂ der Gattung *Coniop-*

[1] Hagen, 1858. *Coniopteryx cerata* sp. n. *Verh. zool.-bot. Ges. Wien*, VIII, p. 484.
[2] Enderlein, 1906. Monographie der Coniopterygiden. *Zool. Jahrb.*, XXIII, Abt. f. Syst., pp. 173—242.

teryx an allen Geisselgliedern vorhanden sind. Flügelmembran farblos, Adern sehr blass bräunlich. Im Vorder-und Hinterflügeltrifft die Querader zwischen Subcosta und R_1 genau auf die Querader zwischen R_1 und R_{2+3}. R_{2+} neigt sichim Vorderflügel vor der Mündung in die Flügelspitze ziemlich stark R^1 zu, so dass die Aderenden einander ziemlich stark genähert erscheinen. Mediangabelzelle ziemlich breit; ihr Stiel trägt basalwärts der Querader ein feines Härchen. Flügelrand ziemlich spärlich und mässig lang pubesciert; Cu_2, An und Ax im Vorderflügel mässig dicht pubesciert. Zwischen M und Cu im Hinterflügel keine Querader. Bestäubung des Korpers und Flügel weiss. Verhältnis der Hintertarsenglieder 10 : 2 : 2 : 2 : 3.

Vorderflugellänge	2·6 mm.
Flügelspannung	6 mm.
Fühlerlänge	1·3 mm.

In my own collection there is a male which probably belongs to the same species. Below are given certain characters in which this male specimen differs from Enderlein's description of the female. I do not consider these differences to be of specific rank. As the male genitalia of *Coniopteryx cerata* have not been figured I show these now (Fig. 13).

Description of Male.

Antennae 1·2 mm. long. Left antenna 27-jointed, right antenna 26-jointed. The antennal joints are ringed with modified hairs as usual in males of *Coniopteryx*. Hind tarsal ratio $7\frac{1}{2}$: $2\frac{1}{2}$: 2 : 2 : $2\frac{1}{2}$. Genitalia as shewn (Fig. 13). Wing venation differing only in minor details from that figured by Enderlein.

Length of body	2 mm.
Length of anterior wing	2 mm.
Length of posterior wing	1·7 mm.

Habitat. Nuwara Eliya, Ceylon, May 1912.

Bred from cocoon by Mr. E. E. Green.

The cocoon is a beautiful object, of white silk, circular in outline and about 2·5 mm. in diameter. It is fluted radially on its upper surface. Mr. Green notes that it was found on a leaf of *Loranthus* associated with *Aleurodes sp.*

Semidalis fletcheri, sp. n.

(Figs. 14 and 26.)

Brownish, covered with white powdery secretion.

Head missing. Thorax wholly dark brown. Abdomen somewhat paler except apex with genitalia which are dark brown. Genitalia very characteristic, differing considerably from other species of *Semidalis* (Fig. 14). Lateral valves placed more dorsally than usual and not so well differentiated off from the rest of segment wall. Penis sclerites almost straight, scarcely curved upwards at their apices.

Legs uniformly brown in colour. Hind tarsal ratio 11 : 3 : 3 : $3\frac{1}{2}$: $4\frac{1}{2}$.

Wings fuscous, venation well-marked (Fig. 26). Cross vein R_1 to Rs strikes Rs before its fork point in all four wings. Cu_2 and 1st A hardly visible in a space near margin of hindwing.

Length of body (without head)	1·5 mm.
Length of anterior wing	2·6 mm.
Length of posterior wing	2·2 mm.

Habitat. Nilgiris, 6,800 feet; Coonoor; 28 February 1920, Fletcher coll. *Holotype* ♂ in British Museum (Natural History).

Semidalis alpina, sp. n.

(Figs. 15 and 27.)

Similar to *Semidalis aleurodiformis*, Stephens. Body and wings fuscous, but completely covered by white powder and thus appearing greyish-white.

Head paler. Eyes rounded, black. Antennae moniliform, dark fuscous, 30-jointed. Palpi dark fuscous.

Thorax and genital segment fuscous, rest of abdomen paler. Genitalia similar to those of *S. aleurodiformis*, Steph., but differing slightly in having more slender and more strongly curved middle processes upon the penunci. (Fig. 15). Legs pale, but with tarsi darker. Hind tarsal ratio 13 : 3 : 3 : $2\frac{1}{2}$: 4.

Wings with veins fuscous and membrane tinged fuscous. The venation (Fig. 27) is similar to that of *Semidalis aleurodiformis*, Steph., var. *curtisiana*, End. Cross-vein from R_1 to Rs strikes the latter before the fork point in all four wings. Marginal setae minute.

Length of body	2·3 mm.
Length of anterior wing	3 mm.
Length of posterior wing	2·4 mm.

Habitat. Kashmir, 8,500 feet; Gulmarg; 17-24 July 1923, Fletcher coll. *Holotype* ♂ in British Museum (Natural History).

This species is very similar to *Semidalis aleurodiformis*, Steph., from which it apparently differs only in its often smaller size and in the male genitalia. The inner, upwardly directed prongs of the penis sclerites are slightly less stout basally in the present species than in true *aleurodiformis*. This small difference may be racial and in giving this form specific rank its close relationship to *aleurodiformis* should not be overlooked. The hind tarsal ratio does not seem to be a good character. It is very variable in this species as also in *aleurodiformis*.

Paratypes.

(1) ♂ Antennae 27-jointed. Cross-vein R_1 to Rs strikes latter before fork point in all four wings. Abbottabad; June 1916, Fletcher coll.

(2) ♂ Antennae 31-jointed. Cross-vein R_1 to Rs strikes latter before fork point in forewings and almost at fork point in hindwings. Simla; 7,000 feet; 31 August 1920, Fletcher coll.

(3) ♀ Antennae 29-jointed. Cross-vein R_1 to Rs proximal to fork point of Rs in all four wings. Simla; 4-7-vi-21; Fletcher coll.

(4) ♀ Antennae 29-jointed. Cross-vein R_1 to Rs proximal for fork point of Rs in all four wings. Dehra Dun, 2,300 feet; 27-xi-18; on *Lantana* flowers; A. G. R. coll.

(5) ? sex. Metathorax with hindwings and abdomen missing. Antennae 29-jointed. Cross-vein R_1 to Rs in forewings proximal to fork point of Rs. Kumaon; Ramgarh, 6,000 feet; 21-26-viii-18; Fletcher coll.

(6) ♀ Antennae 30-jointed. Cross-vein R_1 to Rs proximal to fork-point of Rs in all four wings. Kumaon; Ramgarh, 6,000 feet; 21-26-viii-18; Fletcher coll.

(7) ♀ Antennae 30-jointed. Cross-vein R_1 to Rs before fork point in all except left hindwing where it is at fork point. Kashmir, 8,500 feet; Gulmarg; 17-24 July 1923; Fletcher coll.

(8) ♀ Antennae 31-jointed. Cross-vein R_1 to Rs proximal to fork point of Rs in all four wings. Hazara District; Dungagali, 8,000 feet; 21-24-v-1915; Fletcher coll.

(9) ♀ Antennae 31-jointed. Cross-vein R_1 to Rs strikes latter at fork point in all four wings. Kumaon; Ramgarh, 6,000 feet; 21-26-viii-18; Fletcher coll.

Semidalis poincianae, sp. n.

(Figs. 16 and 28.)

Pale in colour. Covered with white powder.

Head slightly darker than rest of body. Eyes black. Antennae 28-jointed, dark brown in colour, but with the first joint paler and of the same colour as the head. The majority of the antennal joints are as broad as their length. Palpi dark brown.

Thorax and abdomen pale fuscous. Genitalia as figured (Fig. 16). Legs pale fuscous. Hind tarsal ratio 8 : $1\frac{1}{2}$: $1\frac{1}{4}$: $1\frac{1}{4}$: $2\frac{1}{2}$.

Wings (Fig. 28) with venation pale and membrane almost colourless. Sc_2 and cross vein from R_1 to Rs are widely apart and the latter cross-vein is placed proximally to the fork point of Rs except in the left hindwing where it strikes Rs at the fork point. Venation otherwise typical of the genus *Semidalis*. Setae at margin of wing very fine.

Lenth of body	1·5 mm.
Length of anterior wing	1·7 mm.
Lenght of posterior wing	1·36 mm.

Habitat. On *Poinciana* leaf; Pusa; Haq coll., C. No. 1395; 8-vi-1916; ex pupâ.

Holotype ♂ in British Museum (Natural History).

Paratypes. Two other specimens of the same species were bred from cocoons found on *Poinciana* leaves. Unfortunately both specimens lack heads.

(1) ♂ Genitalia as in holotype. Cross vein R_1 to Rs at fork point of latter except in left hindwing where it is proximal to fork point. Pusa; 15-vi-1916: ex pupâ; C. No. 1395.

(2) ♀ Paraprocts very broad and *truncate*, not rounded as is more usual. Cross-vein R_1 to Rs proximal to fork point of latter in all four wings Pusa; 8-vi-1916; ex pupâ; Haq coll.; C. No. 1395.

The three cocoons from which the above specimens were bred are of flat ovoid shape and composed of smooth white silk. There is an inner envelope, of about 1·5 mm. diameter, which is completely fused with the outer envelope. The outer envelope is about 3 mm. in diameter. The cocoons have been spun on the upper surfaces of the *Poinciana* leaves. The pupal skin projects from the ruptured cocoon.

This species can easily be recognised in the male by the genitalia and other characters given above. The female may be distinguished by the peculiar shape of the paraprocts.

EXPLANATION OF FIGURES.

1. *Semidalis aleurodiformis* Steph., egg . . . . . × 67
2. „ „ „ larva, magnified . . . . . ×
3. *Niphadicera terminalis* Bks., (genotype) head from side . . . . . × 53
4. „ „ „ „ maxilla . . . . . × 214
5. „ „ „ „ labium . . . . . × 214
6. „ „ „ „ ♂ abdomen . . . . . × 112
7. *Coniocompsa indica* sp. n., holotype ♂, genitalia . . . . . × 214
8. *Conwentzia inverta* „ „ ♂ „ . . . . . × 214
9. *Nimboa basipunctata* „ „ ♂, „ . . . . . × 214
10. *Coniopteryx exigua* „ „ ♂, „ . . . . . × 214
11. „ *obtusa* „ „ ♂, „ . . . . . × 214
12. „ *pusana* „ „ ♂, „ . . . . . × 214
13. „ *cerata* Hagen, ♂ genitalia . . . . . × 214
14. *Semidalis fletcheri* sp. n., holotype ♂, genitalia . . . . . × 214
15. „ *alpina* sp. n., No. 1, paratype ♂, genitalia . . . . . × 214
16. „ *poincianae* sp. n., holotype ♂, genitalia . . . . . × 214
17. *Niphadicera terminalis* Bks., genotype, wings . . . . . × 30
18. *Coniocompsa indica* sp. n., holotype, wings . . . . . × 30
19. *Conwentzia inverta* „ „ „ . . . . . × 30
20. *Nimboa basipunctata* „ „ „ . . . . . × 30
21. „ *immaculata* „ „ „ . . . . . × 30
22. *Coniopteryx exigua* „ „ „ . . . . . × 30
23. „ *ambigua* „ „ „ . . . . . × 30
24. „ *obtusa* „ „ „ . . . . . × 30
25. „ *pusana* „ „ „ . . . . . × 30
26. *Semidalis fletcheri* sp. n., holotype, wings . . . . . × 30
27. „ *alpina* sp. n., No. 1, paratype, wings . . . . . × 30
28. „ *poincianae* sp. n., holotype, wings . . . . . × 30

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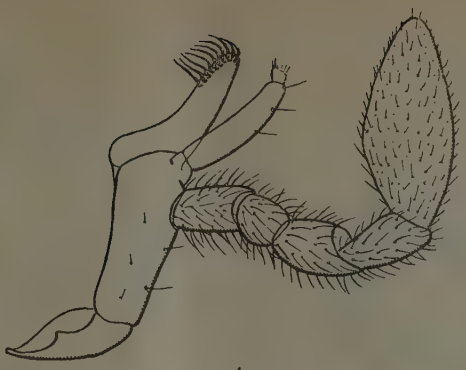

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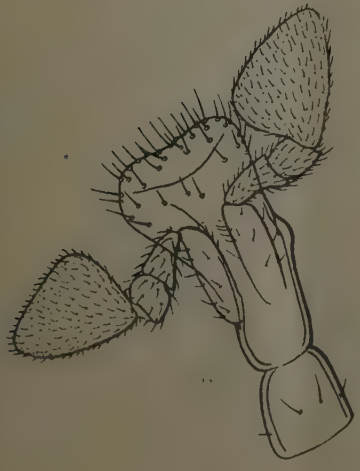

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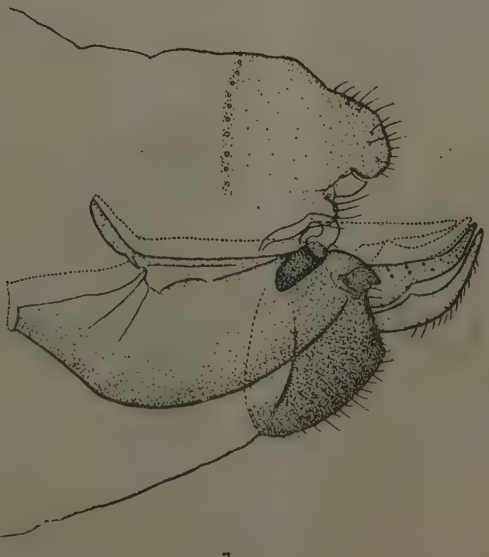

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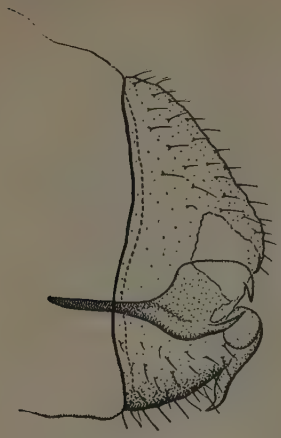

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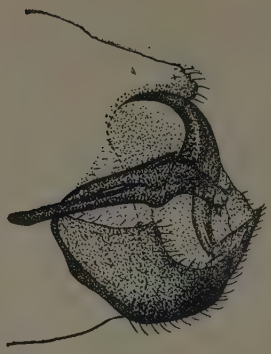

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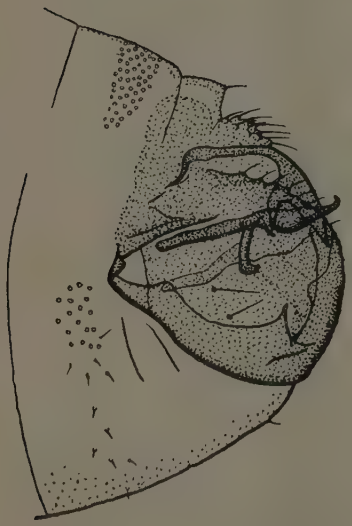

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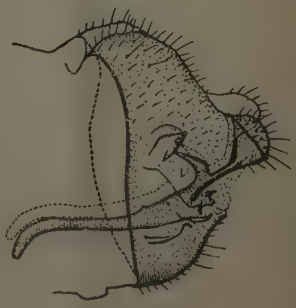

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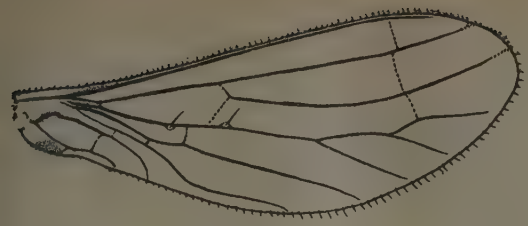

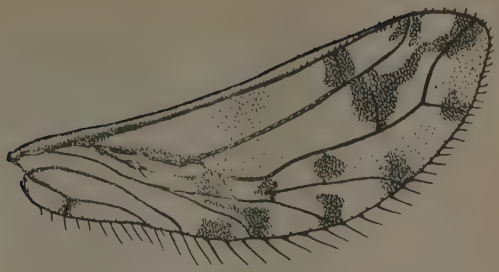

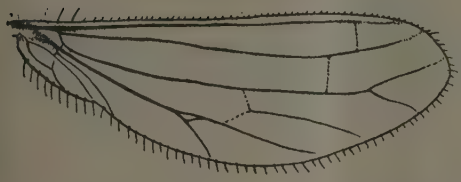

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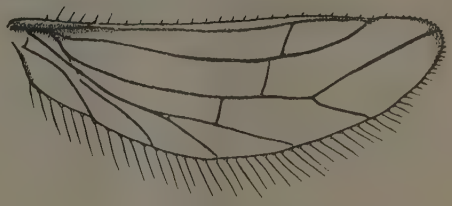

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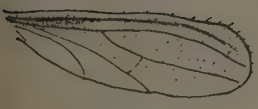

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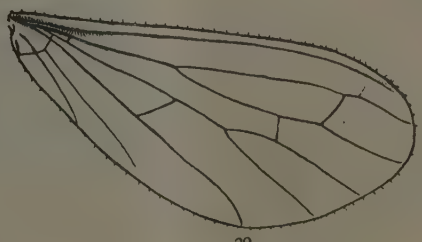

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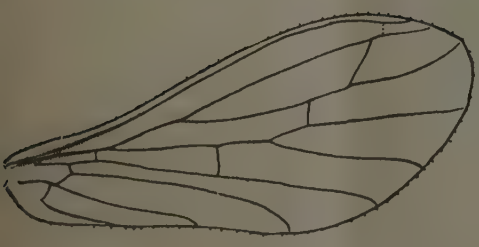

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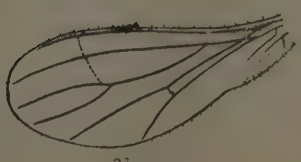

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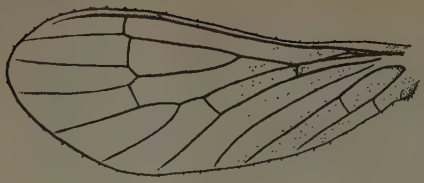

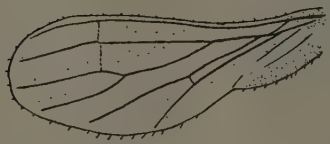

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Memoirs of the Department of Agriculture in India

Papers on Indian Tabanidæ

VIII. The Bionomics and Life-histories of some of the common Tabanidæ of Pusa

BY

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THE BIONOMICS AND LIFE-HISTORIES OF SOME OF THE COMMON TABANIDÆ OF PUSA.

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(Received for publication on 27th January 1925.)

Introduction.

Many of the species of flies of the family Tabanidae found on the Plains of India occur in Pusa (Bihar, North India) and during certain seasons they are fairly abundant. *Tabanus tenens*, Wlk., *T. striatus*, Fabr., *T. rubidus*, Wied., *T. macer*, Bigot (=*bicallosus*, Ric.), *T. nemocallosus*, Ric., *T. virgo*, Wied., and *T. crassus*, Wlk., are plentiful, and of *Gastroxides ater*, Saund, though the imagines are rarely seen, the larvae are easily collected. Some species of *Chrysops* and of *Haematopota* o. exist, but their life-histories have not been studied in full. The life-histories of *T. crassus*, Wlk., and of *T. striatus*, Fabr., were treated by the writer in his earlier papers on Indian Tabanidae.[1]

Tabanus macer, Bigot.

T. macer, Big. (=*bicallosus*, Ric.) is smaller than most other representatives of the genus *Tabanus*. The female sucks blood from cattle and is generally active from mid-day till evening attacking animals standing in the sun and generally prefering the venter of the abdomen to bite.

Life-history.

Egg. Eggs are laid in a mass of about 200 to 300 on low foliage overhanging water (Pl. V, fig. 1). When ovipositing the female sits vertically with its head down. About six eggs are first laid and stuck to the leaf or twig in an almost upright row. More rows are added on row over row. All the rows have nearly equal number of eggs; only the number of rows may vary in different egg masses which

[1] The life-history of *T. crassus*, Wlk. *Mem. Dept. Agri., India, Entl. Ser.*, Vol. VIII, No. 5.
Notes on the life-history of *T. striatus*, Fabr. *Mem. Dept. Agri., India, Entl. Ser.*, Vol. VIII, No. 10, vii.

when finished always present a neatly packed appearance. Each egg is about 1·2 mm. long, torpedo shaped and slaty black. The eggs are pearly white when just laid, but they darken on exposure. The incubation period is 4 or 5 days in summer.

Larva. The newly hatched larva is about 1·5 mm. long and whitish. It wriggles out of the egg-shell and drops into the water and within a half hour moults throwing off the body cuticle and the head covering which in the first instar of the larva does not show any oral appendages, but only a dorsal process for breaking the chorion. The second instar larva (Pl. VI, fig. 1a) is quite 2 mm. long, has the normal oral appendages functioning and possesses two pairs of auto-liths at the posterior end. The lateral tracheae are narrow and the larvae are unable to float in water and therefore perish if they cannot creep into wet earth.

The larva lives in the damp earth a few inches above the edge of the water and about 4 inches below the surface and preys on soil organisms and is also cannibalistic. As it grows it becomes brownish in colour the appearance being due to dark cross-bands on the abdomen. It passes through seven instars.

The full grown larva (Pl. VI, fig. 1) is about 20 mm. long, and may appear slightly longer when the head and the anal siphon are fully eversed.

The larval period is about four weeks except in the cold season brood, when due to hibernation it extends to about 16 weeks.

Pupa. The pupa is found in the soil where the larva lived but closer to the surface. It is about 15 mm. long, and brownish (Pl. VII, fig. 1). The abdominal segments have rather prominent rings of spines. The pupal period is about 5 days in summer and about 15 days in the cold season.

Imago. It is easy to distinguish the sexes (Pl. VIII, figs. 1*a*, 1*b*, 1*c*, 1*d* and 1*e*). The female readily sucks blood from cattle and the male in capacity feeds on syrup. Males are rarely seen in nature. When alive the eyes in both sexes are beautiful.

Broods.

There are three broods in the year. Imagines appear and lay eggs first in March and April, then about July and also in October and November.

Tabanus rubidus, Wied.

T. rubidus, Wied. (=*albimedius*, Wlk.) is perhaps the largest Tabanid found on the Indian Plains. The female flies are active when the day is bright and warm and attack cattle for their blood.

Life-history.

Egg. Eggs are laid in large oval masses on twigs and leaves overhanging water—usually there are about 600 eggs in one laying (Pl. V, figs. 2, 2*a* and 3). Each egg is 2 mm. long and cigar shaped and brownish gray. It takes nearly 45 minutes

for a female to lay one mass of eggs, extruding one egg after another and as each is laid shaping the mass with the aid of the terminal plates on the abdomen. The eggs are pearly white when laid but darken in the sun. The eggs hatch in 4 days. Hatching invariably takes place at sun-rise.

Larva. The just hatched larva is about 2·2 mm. long. As soon as it has wriggled out of the egg-shell it drops down into the water and immediately moults. The mouth-appendages appear in the second instar larva (Pl. VI, fig. 2*a*) which is 2·5 mm. long, it is able to float as it has large lateral tracheae. There are two pairs of autoliths in this instar.

These larvae live in the wet soil close to the water edge and sometimes even burrow down below the water level, their tracheal system saving them from drowning. They feed on soil organisms and sometimes attack one another. In confinement they eagerly feed on earth-worms and fly-maggots. They pass through seven instars.

The full-grown larva is about 35 mm. long and whitish in colour (Pl. VI, fig. 2). It is very active. The larval period is about 6 weeks when there is no hibernation.

Pupa. Pupae are found in the soil near the water edge. The pupa is about 25 mm. long (Pl. VII, fig. 2). The pupal period is usually 7 days.

Imago. The sexes may be distinguished by the eyes (Pl. VIII, figs. 2*a*, 2*b*, 2*c*, 2*d* and 2*e*). The males are very seldom seen. The females are easily watched and collected where they frequent for egg-laying. They occasionally lay eggs on plants on the banks of stagnant pools, on foliage several feet above water and rarely even on walls with no water in the vicinity.

Broods.

There are three broods in the year corresponding with those of *T. macer* Big. mentioned earlier.

Tabanus tenens, Wlk.

T. tenens, Wlk. (=*striatus*, auct. *nec* Fabr.) is the most abundant form at Pusa. It is most active at sun-set, just before dusk, when the females come in large numbers to cattle. They prefer the stomach and the lower portion of the legs to bite.

Life-history.

Egg. The eggs are laid in a mass on twigs and leaves just above water along the margin of small streams (Pl. V, fig. 4). There are about 200 to 300 eggs in one mass which when fresh is pearly white in colour, but in a few hours the eggs become dark brown. Each egg is about 1·7 mm. long and cigar shaped. The eggs hatch all together, in the early morning 4 days after they are laid.

Larva. The first instar larva is nearly 2 mm. long and moults as soon as it drops into the water. The second instar larva (Pl. VI, fig. 4*a*) is 2 mm. long and

having large lateral tracheae is able to float. It burrows into the bank and lives at the water-edge. In breeding cages these larvae do well on a diet of fly-maggots. They are cannibalistic.

The larva moults six times before it becomes full-grown and then attains the maximum length of 30 mm. in the seventh instar (Pl. VI, fig. 4). The larval stage occupies about six weeks in summer.

Pupa. The pupa (Pl. VII, fig. 4) is found in the soil where the larval stage was passed but closer to the surface. It is about 20 mm. long. The pupal period is usually 9 or 10 days.

Imago. The eyes in the female are dull, but in the male they are brightly coloured (Pl. VIII, figs. 4*a*, 4*b*, 4*c*, 4*d* and 4*e*). The males occasionally and females often are seen seated on shaded tree trunks or the walls of houses.

Broods.

The usual three annual broods are present in this species also.

Tabanus virgo, Wied.

This is the smallest *Tabanus* found on the Plains. The eggs are said to be laid in small masses on foliage hanging over streams, but no egg masses have been collected at Pusa. Larvae and pupae are however found in numbers in the damp soil on the banks of streams.

Life-history.

Larva. The full grown larva (Pl. VI, fig. 5) is about 16 mm. long and brownish in colour. Its posterior end is rather blunt.

Pupa. The pupa (Pl. VII, fig. 5) is found in the soil as mentioned above. It is about 12 mm. long. The pupal period extends over 6 days.

Imago. The eyes distinguish the sexes (Pl. X, figs. 5*a*, 5*b*, 5*c*, 5*d*, and 5*e*). The females suck blood from cattle. Both sexes were once observed coming in numbers to the lights in a running train.

Broods.

This species has the three annual broods along with that of the other Tabanids treated in this paper.

Tabanus nemocallosus, Ricardo.

The adults of this species are not often seen, but the larvae are very common in the soil along the river bank. The female sucks blood from cattle.

Life-history.

Egg. The eggs are laid in masses (Pl. V, fig. 5) of about 100 to 200 or 300 on leaves and twigs over shallow water along river-banks. Several egg-masses are

often found crowded on the same leaf close to one another and sometimes one mass partly over another. Each egg is 1·2 mm. long, torpedo shaped and slaty black. The egg-masses are elongated and the eggs are a little more slanting than in those of *T. macer*, Big. with which these are easily confused. The outline of the egg-mass is irregularly rounded and thus different from that of the more angular block into which *T. macer*, Bigot, builds its eggs. The egg-period is about 4 days.

Larva. The newly-hatched larva is 1·5 mm. long and moults as soon as it has fallen into the water. The second instar larva (Pl. VI, fig. 6*a*) is 2 mm. long and whitish and has very narrow lateral tracheae and is unable to float. It seems to have only one pair of autoliths at this stage. This and the more marked bunches of spines on the parapodia distinguish these larvae from the same stage larvae of *T. macer*, Big.

The full grown larva (Pl. VI, fig. 6) is 30 mm. long, narrow bodied and yellowish white. The parapodia are very marked. The larvae are found in large numbers in the soil on the river bank about two feet away from the water and 3 or 4 inches below the surface. They seem to have a preference for hard caked up damp earth and they do not attack one another. In captivity the larvae refused to feed on earth worms, maggots or chironomid larvae or culicid larvae. Therefore the length of the larval stage could not be determined.

Pupa. The pupa (Pl. VII, fig. 6) is found close to the surface in the soil along the river bank. It is light brown in colour and about 20 mm. long. The pupal period is 9 or occasionally 10 days.

Imago. The sexes differ in the size and colour of eyes (Pl. X, figs. 6*a*, 6*b*, 6*c*, 6*d* and 6*e*). Gorged females are sometimes caught in bushes waiting to lay eggs.

Broods.

At Pusa this species has three broods concurrent with those of the other common Tabanids.

Gastroxides ater, Saunders.

This belongs to the family Tabanidae. The larvae are found in the muck in holes in tree trunks. The adults are rarely seen. The mouth-parts of the female suggest that they are intended for piercing and sucking.

Life-history.

The eggs or first stage larvae have not been observed. The full grown larva (Pl. VI, fig. 3) is about 24 mm. long and yellowish white with sometimes a tinge of red. It feeds apparently on organisms around it sucking their juices. The larva can remain without food for very long periods.

Pupa. The pupa (Pl. VII, fig. 3) is blackish. It is about 22 mm. long and occurs in the same site as where the larva is found. The pupal stage lasts 6 days.

Imago. The adults (Pl. IX, figs. 3*a*, 3*b*, 3*c*, 3*d* and 3*e*) have besides the difference in the eyes in the two sexes, in the male a dark brown band across the base of the abdomen at its base.

Broods.

There is only one brood in the year. Imagines emerge in June and July. Hibernation takes place in the larval stage. The larval growth is very slow.

Remarks on the common Tabanidæ of Pusa.

In all observed cases the first instar larva has no mouth-parts, but has a mask-like head covering with a dorsal anterior toothed process for breaking open the egg-shell.

Tabanid larvae in general are able to withstand long periods of fast. Owing to dearth of food, therefore, apart from the regular broods it is possible that imagines emerge at times on irregular occasions.

The pupae of the several species are distinct in general appearance and particularly in the cluster of posterior terminal spines termed together as the pupal aster.

The colour of the eyes of the imagines vary, but in dry specimens they all lose the metallic lustre and other features present in life. In the plates of imagines in this paper the colours are taken from living forms.

EXPLANATION OF PLATES.

Plate V. *Egg-masses of Tabanidæ.*

1. Egg-mass of *T. macer*, Bigot . . . . . × 4
2. „ *T. rubidus*, Wied. . . . . × 4
2*a*. Single egg of „ „ . . . . . ×10
3. Egg-mass of „ „ (dorsal view) . . . . . × 4
4. „ *T. tenens*, Wlk. . . . . × 4
5. „ *T. nemocallosus*, Ric. . . . . × 4
6. „ *T. macer*, Bigot . . . . . × 4

Plate VI. *Larvae of Tabanidæ.*

1. Larva of *T. macer*, Bigot, Full grown . . . . . × 3·5
1*a*. „ „ „ Second instar . . . . . ×16
2. „ *T. rubidus*, Wied., Full grown . . . . . × 3
2*a*. „ „ „ Second instar . . . . . × 16
3. „ *G. ater*, Saund, Full grown . . . . . × 3·5
4. „ *T. tenens*, Wlk., Full grown . . . . . × 3·5
4*a*. „ „ „ Second instar . . . . . × 18
5. „ *T. virgo*, Wied., Full grown . . . . . × 3·5
6. „ *T. nemocallosus*, Ric., Full grown . . . . . × 3·5
6*a*. „ „ „ Second instar . . . . . ×18

Plate VII. *Pupae of Tabanidæ.*

Showing features of the pupae of—

1. *T. macer*, Bigot; 2. *T. rubidus*, Wied.; 3. *G. ater*, Saund; 4. *T. tenens*, Wlk.; 5. *T. virgo*, Wied. and 6. *T. nemocallosus*, Ric.

a. Pupa . . . . . × 3
b. Ventral view of posterior extremity of female pupa . . . . . × 9
c. Ditto ditto male pupa . . . . . × 9
d. Pupal aster . . . . . ×18

Plate VIII. *Adult Tabanids.*

1*a*. *T. macer*, Bigot ♀ . . . . . × 3·5
1*b*. and 1*c*. Head of same, front view and lateral view . . . . . much enlarged.
1*d*. *T. macer*, Bigot ♂ . . . . . × 3·5
1*e*. Head of same, lateral view . . . . . much enlarged.
2*a*. *T. rubidus*, Wied. ♀ . . . . . × 2
2*b*. and 2*c*. Head of same, front view and lateral view . . . . . much enlarged.
2*d*. *T. rubidus*, Wied. ♂ . . . . . × 2
2*e*. Head of same, lateral view . . . . . much enlarged.

Plate IX. *Adult Tabanids.*

3*a*. *G. ater*, Saund ♀ . . . . . × 2
3*b*. and 3*c*. Head of same front view and lateral view . . . . . much enlarged.
3*d*. *G. ater*, Saund ♂ . . . . . × 2
3*e*. Head of same, lateral view . . . . . much enlarged.
4*a*. *T. tenens*, Wlk. ♀. . . . . × 2
4*b*. and 4*c*. Head of same, front view and lateral view . . . . . much enlarged.
4*d*. *T. tenens*, Wlk. ♂ . . . . . × 2
4*e*. Head of same, lateral view . . . . . much enlarged.

Plate X. *Adult Tabanids.*

5*a*. *T. virgo*, Wied. ♀. . . . . × 4
5*b*. and 5*c*. Head of same, front view and lateral view . . . . . much enlarged.
5*d*. *T. virgo*, Wied. ♂. . . . . × 4
5*e*. Head of same, lateral view . . . . . much enlarged.
6*a*. *T. nemocallosus*, Ric ♀. . . . . × 2·5
6*b*. and 6*c*. Head of same, front view and lateral view . . . . . much enlarged.
6*d*. *T. nemocallosus*, Ric. ♂. . . . . × 2·5
6*e*. Head of same, lateral view . . . . . much enlarged.

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EGG-MASSES OF TABANIDÆ

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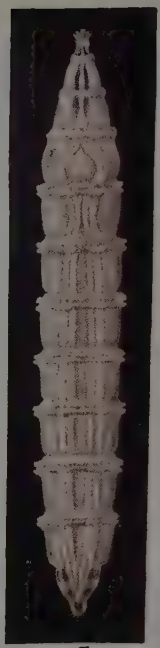
2a



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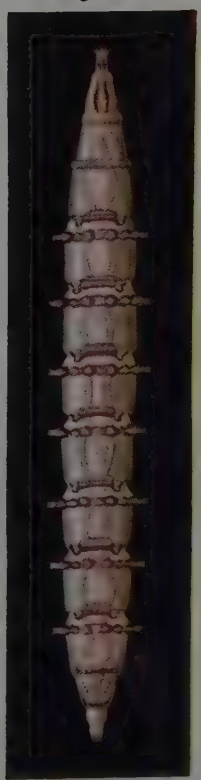

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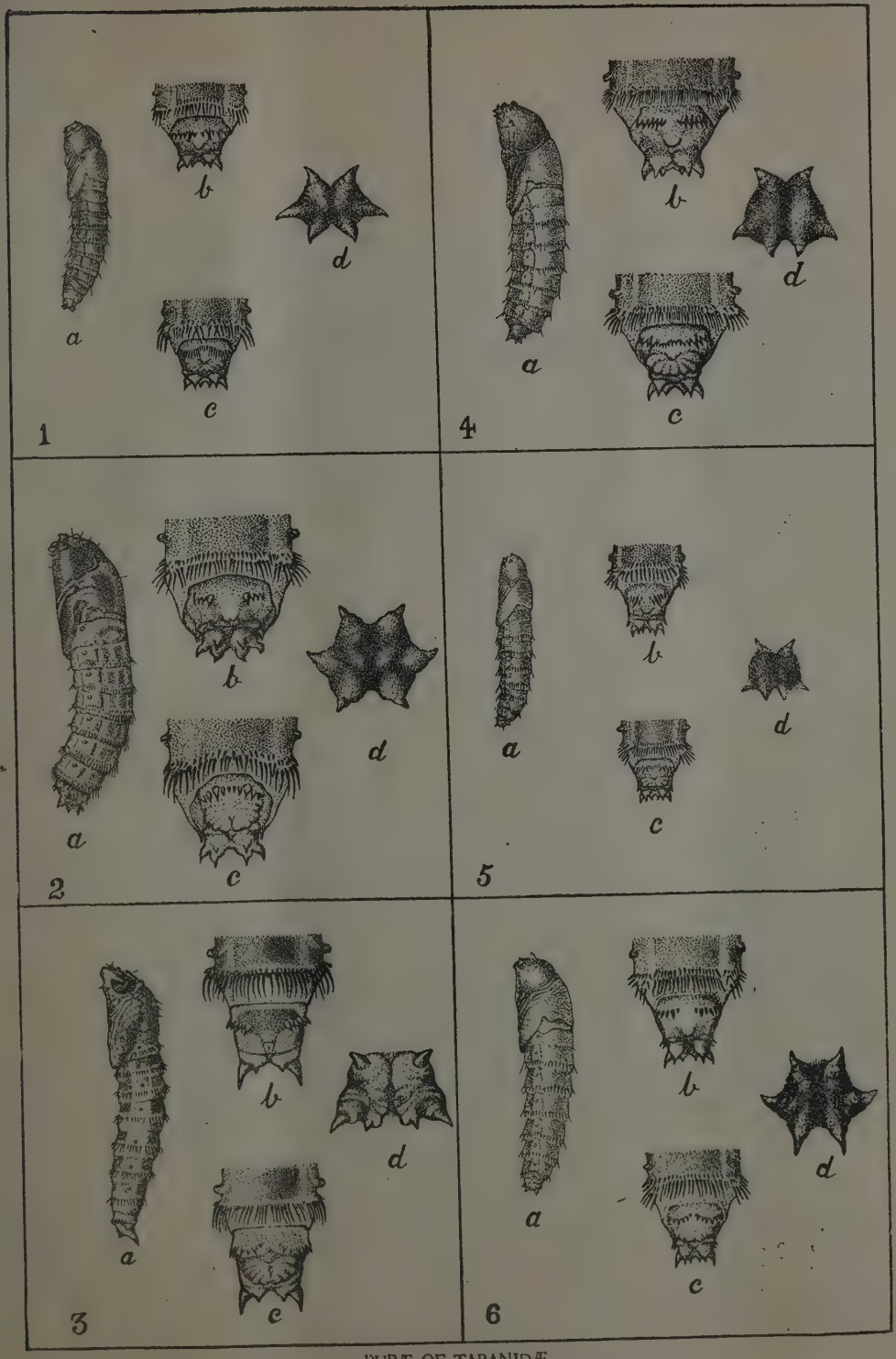
LARVÆ OF TABANIDÆ



PUPÆ OF TABANIDÆ.

TABANUS MACER, BIGOT AND T. RUBIDUS, WIED.

GASTROXIDES ATER, SAUND. AND T. TENENS, WLK.

TABANUS VIRGO, WIED. AND T. NEMOCALLOSUS, RIC.

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Some observations on the Life-history and Habits of Phycus brunneus, Wied. (Family Therevidæ)

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SOME OBSERVATIONS ON THE LIFE-HISTORY AND HABITS OF *PHYCUS BRUNNEUS*, WIED. (FAMILY *THEREVIDÆ*).

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(Received for publication on 27th January 1925.)

Very little is known of the life-history and habits of the flies of the family *Therevidæ*. As the imagines are generally predaceous the family deserves more attention from economic entomologists, while the morphologist may find much that is interesting in the structure of the larva.

According to Williston[1] (1908) the adults prey on other Diptera for which they lie in wait. Lefroy[2] (1909) says that the adults are predators on insects, but there is no information as to the forms they mostly prey on. The young larvae according to Verrall[3] (1909) probably live in loose earth and sand and are ready to prey upon any vegetable or animal refuse or even to affix themselves to living larvae. Malloch[4] (1917) states that the larvae are found in the ground and also in decaying wood and are predaceous feeding on various insect larvae and are apt to be cannibalistic.

Phycus brunneus, Wiedemann.

It is believed that the few observations I have made on the life-history and habits of *P. brunneus*, Wied. will be of interest and will add to our knowledge of the family. The imagines have been found in Pusa (Prov. Bihar, India) during the months of March and April. The egg stage is not known, but the larvae occur among the excreta of bats in crevices and fissures in walls.

The mature larva. (Pl. XI, figs. 1, 2 and 3.) The full grown larva is about 20 mm. long and of a shiny yellowish white colour. It has a snake-like appearance. The larva is eucephalous and amphi-pneustic, is quite smooth and possesses a single

[1] Williston (1908). North American Diptera.
[2] Lefroy (1909). Indian Insect Life.
[3] Verrall (1909). British flies.
[4] Malloch (1917). A preliminary classification of Diptera, exclusive of Pupipara, based upon larval and pupal characters with keys to the imagines of certain families, *Part I, Bull. III, St. Lab. of Nat. Hist., Vol. XII, Art. III.*

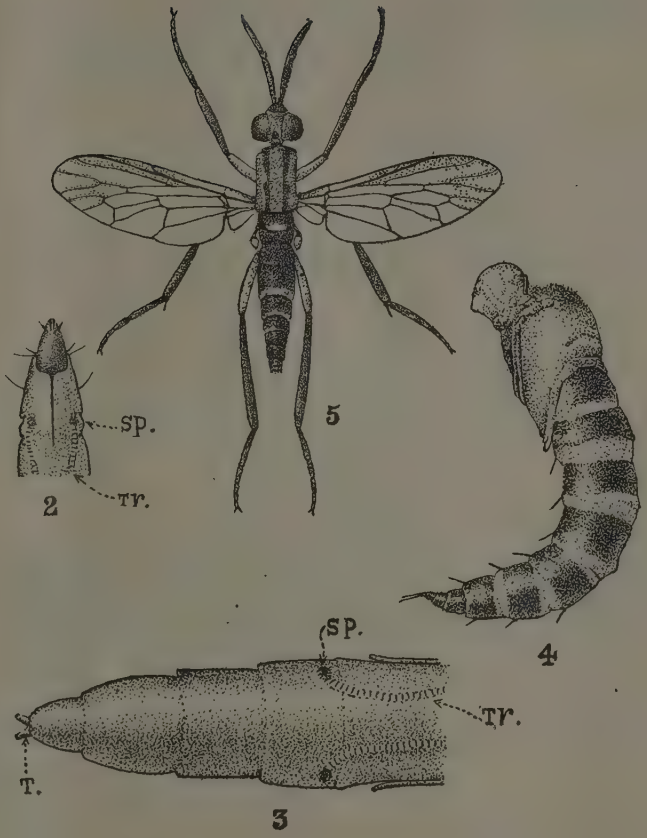
pair of pseudo-pods at the tip of the ultimate segment which is usually folded ventrad. The long snaky body is divided into twenty segments, this appearance being due according to Malloch to the false division into two of each of the first six abdominal segments. The first pair of spiracles are on the first thoracic segment, not on the second segment as stated by Brunetti (1920) and the posterior pair of spiracles are on the fourth segment from the anal end.

The food of the larva. The larva is predaceous and occasionally cannibalistic, wherefore not more than one or two of these larvae are found in the same situation. The organisms preyed on are chiefly Dermestid larvae which are fairly plentiful in bat excreta owing to the presence therein of chitinous insect tissue. The *P. brunneus* Wied. larva sucks its prey and it is not unusual to see the sucked out shrivelled body of a small larva of the species when a number of these are reared together in the same cage.

The Pupa. (Pl. XI, fig. 4.) The pupa is about 12 mm. long, of a brownish colour and with the abdomen curved and always has a quantity of extraneous matter sticking to it evidently for protection as there is no real cocoon. The pupal period seems to extend from seven to twelve days.

The imagines. Both sexes are very much alike, the eyes are dichoptic in both but the male has the abdominal tip turned upward and also has the genital armature fairly visible. The flies are very active and resemble some of the Hymenoptera in their movements specially in the rapid beating movements in the air of the forelegs. They are predaceous and are sometimes found on glass windows. Once I took one when it had caught and almost overpowered a common house-fly.

1



Phycus brunneus, Wied.

1. Mature larva × 6; 2. Anterior end of larva, much enlarged; sp. spiracle; Tr. trachea; 3. Posterior end of larva, much enlarged; T. terminal pseudopods; other letters as before; 4. Pupa × 6; 5. Imago, Female × 6.

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